PB-240 230

LAKE CHEMUNG, LIVINGSTON COUNTY, MICHIGAN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center, Corvallis, Oregon
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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

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REPORT
ON
LAKE CHEMUNG
LIVINGSTON COUNTY
MICHIGAN

EPA REGION V

WORKING PAPER No. 189

WITH THE COOPERATION OF THE

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

AND THE

MICHIGAN NATIONAL GUARD

FEBRUARY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identfying point sources and soliciting municipal participation in the Survey.

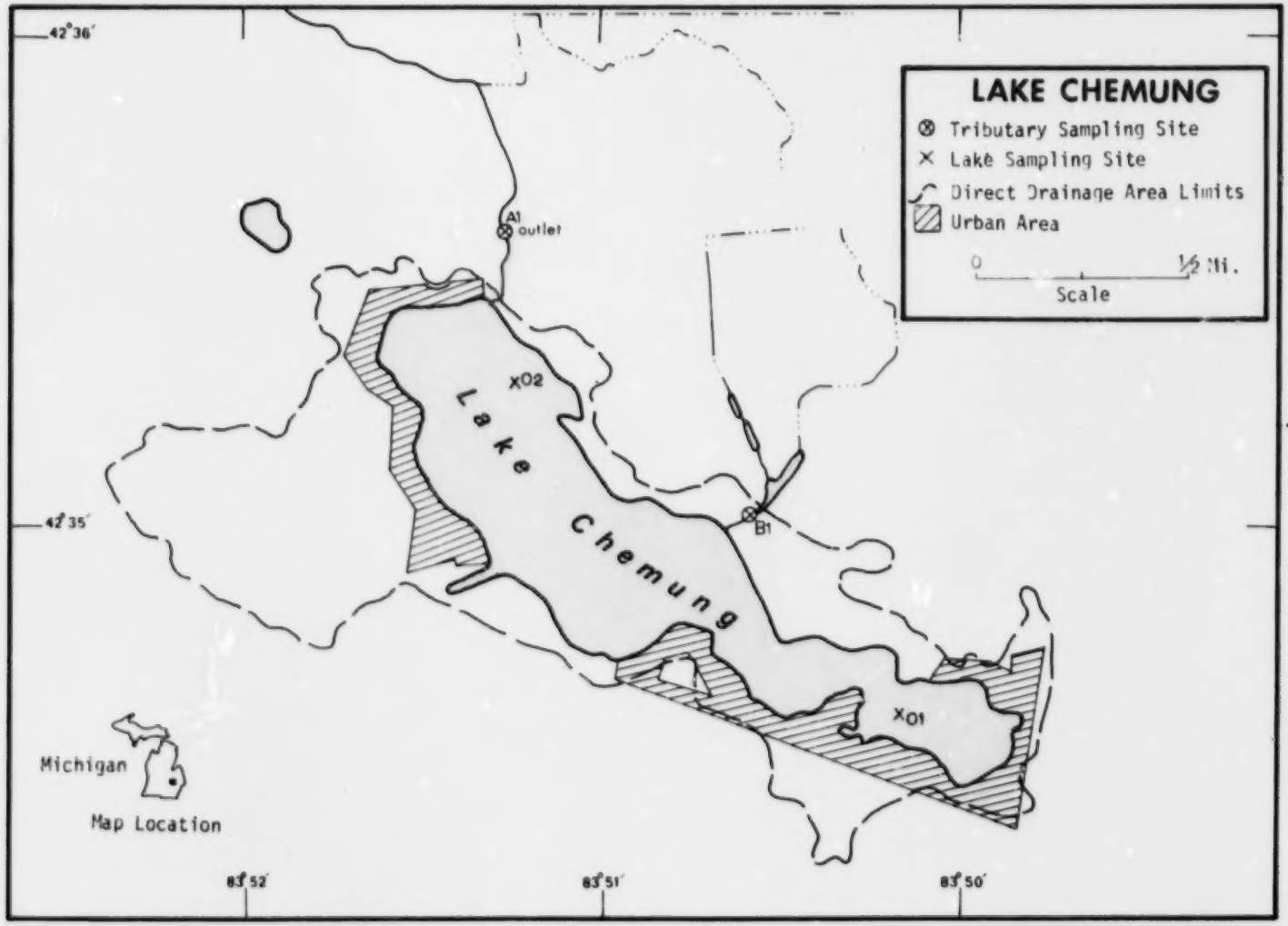
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


LAKE CHEMUNG
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Limits
Urban Area
0
½ Mi.
Scale
A1
outlet
X02
Lake Chemung
B1
X01
42°36'
42°35'
85°52'
85°51'
85°50'
Michigan
Map Location

LAKE CHEMUNG

STORET NO. 2618

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others (Ketelle and Uttormark, 1971) show that Lake Chemung is eutrophic. Of the 35 Michigan lakes sampled in November when essentially all were well-mixed, 17 had less mean total phosphorus, nine had less mean dissolved phosphorus, but only one had less mean inorganic nitrogen; of the 41 Michigan lakes sampled, 23 had less mean chlorophyll a, but only five had greater Secchi disc transparency*. Depletion or near-depletion of dissolved oxygen occurred at and below 25 feet at both sampling stations in June and in September.

Reportedly (Ketelle and Uttormark, op. cit.), rooted aquatic vegetation grows profusely in the shallower areas of the lake.

B. Rate-Limiting Nutrient:

The algal assay results and the lake data show that Lake Chemung was phosphorus limited in September, 1972. However, the lake data indicate nitrogen limitation in June and November.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Lake Chemung received a total phosphorus load at a rate less than that

* See Appendix A.

proposed by Vollenweider (in press) as "dangerous" but greater than his suggested "permissible" rate; i.e., a mesotrophic rate (see page 12).

Other than septic tanks, there are no known point sources impacting Lake Chemung. However, the favorable mesotrophic phosphorus loading rate may be due to underestimation of septic tank loads. A shoreline survey would be needed to determine the actual contributions.

2. Non-point sources--It is estimated that non-point sources, including precipitation, contributed about 48% of the total phosphorus load to Lake Chemung during the sampling year.

The phosphorus export of the Unnamed Creek (B-1) does appear to be excessive and is comparable to the exports of other unimpacted Michigan streams sampled during the Survey year (see page 12).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 310 acres.
2. Mean depth: 28.3 feet.
3. Maximum depth: 70 feet.
4. Volume: 8,773 acre-feet.
5. Mean hydraulic retention time: 4.2 years

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Unnamed Creek (B-1)	1.6 mi^2	0.9 cfs
Minor tributaries & immediate drainage -	3.3 mi^2	2.0 cfs
Total	4.9 mi^2	2.9 cfs

2. Outlet -

Unnamed Creek (A-1)	5.4 mi^2**	2.9 cfs

C. Precipitation:

1. Year of sampling***: 32.6 inches.
2. Mean annual: 33.1 inches.

† MI Dept. Cons. lake inventory map (1942); mean depth by random-dot method.
* Drainage areas are accurate within ±5%; mean daily flows for 74% of the sampling sites are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.
** Includes area of lake.
*** See Working Paper No. 1, "Survey Methods, 1972".

III. LAKE WATER QUALITY SUMMARY

Lake Chemung was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the second visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analyses. The maximum depths sampled were 35 feet at station 1 and 65 feet at station 2.

The results obtained are presented in full in Appendix C, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix C.

A. Physical and chemical characteristics:

FALL VALUES

(11/15/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	6.0	6.5	6.7	6.8
Dissolved oxygen (mg/l)	6.8	8.4	7.4	10.2
Conductivity (μmhos)	405	412	410	420
pH (units)	7.6	7.7	7.6	7.9
Alkalinity (mg/l)	134	135	135	137
Total P (mg/l)	0.032	0.044	0.037	0.072
Dissolved P (mg/l)	0.013	0.014	0.014	0.014
NO_2 + NO_3 (mg/l)	0.020	0.023	0.020	0.040
Ammonia (mg/l)	0.040	0.109	0.150	0.180

ALL VALUES

Secchi disc (inches)	66	96	74	144

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/15/72	1. Dinobryon	1,304
	2. Oocystis	407
	3. Gloeocapsa	347
	4. Oscillatoria	113
	5. Melosira	98
	Other genera	361
	Total	2,630
09/19/72	1. Microcystis	1,236
	2. Oscillatoria	1,034
	3. Anabaena	672
	4. Lyngbya	427
	5. Aphanocapsa	383
	Other genera	709
	Total	4,461
11/15/72	1. Lyngbya	2,132
	2. Oscillatoria	675
	3. Dinobryon	229
	4. Microcystis	193
	5. Anabaena	157
	Other genera	613
	Total	3,999

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/15/72	01	7.3
	02	7.2
09/19/72	01	8.3
	02	6.9
11/15/72	01	32.0
	02	19.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.012	0.192	2.7
0.005 P	0.017	0.192	3.2
0.010 P	0.022	0.192	3.8
0.020 P	0.032	0.192	3.5
0.050 P	0.062	0.192	3.6
0.050 P + 10.0 N	0.062	10.192	23.8
10.0 N	0.012	10.192	2.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Chemung was moderately high at the time the sample was collected (09/19/72). Also, increasing yields with increasing increments of orthophosphorus, up to about 0.020 mg/l, indicate that the lake was phosphorus limited. At

orthophosphorus concentrations higher than about 0.020 mg/l, yields do not change significantly until nitrogen is also added. This indicates the lake probably would become nitrogen limited if orthophosphorus concentrations exceeded 0.020 mg/l (assuming nitrogen concentrations did not change). Note that the addition of only nitrogen resulted in a yield not significantly different from the control yield.

The lake data also indicate phosphorus limitation in September (N/P ratio = 15/1). However, nitrogen limitation is indicated for June and November (N/P ratios were less than 10/1, and nitrogen limitation would be expected).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Michigan National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May, when two samples were collected, and December when low flows prevented sampling. Sampling was begun in October, 1972, and was completed in October, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S) were estimated by using the nutrient loads, in $lbs/mi^2/year$, in the unnamed creek at station B-1 and multiplying by the ZZ area in mi^2.

There are no known municipal or industrial point sources impacting Lake Chemung.

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* See Working Paper No. 1.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed Creek (B-1)	80	13.3
b. Minor tributaries & immediate drainage (non-point load) -	160	26.7
c. Known municipal STP's - None	-	-
d. Septic tanks* -	310	51.7
e. Known industrial - None	-	-
f. Direct precipitation** -	50	8.3
Total	600	100.0

2. Outputs -

Lake outlet - Unnamed creek 220

3. Net annual P accumulation - 380 pounds

* Estimate based on 490 shoreline dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed Creek (B-1)	3,710	14.3
b. Minor tributaries & immediate drainage (non-point load) -	7,650	29.6
c. Known municipal STP's - None	-	-
d. Septic tanks* -	11,520	44.5
e. Known industrial - None	-	-
f. Direct precipitation** -	2,990	11.6
Total	25,870	100.0

2. Outputs -

Lake outlet - Unnamed creek 7,960

3. Net annual N accumulation - 17,910 pounds

* Estimate based on 490 shoreline dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Unnamed Creek (B-1)	50	2,319

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	1.9	1.2	83.5	57.8
grams/m^2/yr	0.22	0.14	9.4	6.5

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time of Lake Chemung:

"Dangerous" (eutrophic rate)	0.28
"Permissible" (oligotrophic rate)	0.14

V. LITERATURE REVIEWED

Ketelle, Martha J., and Paul D. Uttormark, 1971. Problem lakes of the United States. EPA Water Poll. Contr. Res. Ser., Proj. 16010 EHR.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500-MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15-MIN UD
2680	HOLLOWAY RESERVOIR	0.062	0.043	1.461	439.375	18.678	9.200
2681	CAMO RESERVOIR	0.117	0.022	3.835	473.000	11.967	9.500
2682	BOARDMAN HYDRO POND	0.006	0.005	0.358	363.500	1.267	6.600
2683	ALLEGAN LAKE	0.123	0.057	1.168	470.222	20.311	12.600
2686	HARTON LAKE	0.121	0.086	1.489	456.167	27.800	14.850
2689	BELLEVILLE LAKE	0.118	0.048	1.428	469.250	28.262	8.200
2610	BETSIE LAKE	0.025	0.008	0.273	481.667	4.567	7.400
2613	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2617	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.008	9.240
2618	LAKE CHEMUNG	0.044	0.014	0.132	404.333	13.483	14.800
2621	CONSTANTINE RESERVOIR	0.027	0.008	0.910	456.167	39.317	7.500
2629	FORD LAKE	0.105	0.058	1.536	456.167	14.733	14.000
2631	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.600
2640	JORDAN LAKE	0.180	0.144	1.998	427.667	20.517	14.900
2643	KENT LAKE	0.048	0.015	0.417	455.000	33.944	13.000
2648	LAKE MACATAWA	0.197	0.120	2.358	477.600	25.600	12.200
2649	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.300
2659	MUSKEGON LAKE	0.087	0.043	0.489	436.444	9.511	14.800
2665	PENTWATER LAKE	0.027	0.017	0.498	430.667	16.083	14.800
2671	RANDALL LAKE	0.246	0.183	0.818	457.333	27.217	8.020
2672	ROGERS POND	0.026	0.015	0.183	435.500	8.133	9.600
2673	RUSS RESERVOIR	0.034	0.021	0.460	465.333	10.383	8.200
2674	SANFORD LAKE	0.016	0.008	0.307	458.750	13.791	8.300
2683	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.650	10.400
2685	UNION LAKE	0.083	0.064	1.252	455.500	15.667	8.200
2688	WHITE LAKE	0.027	0.019	0.367	417.778	9.211	13.400
2691	MUNA LAKE	0.307	0.241	0.983	451.667	27.783	14.100
2692	LONG LAKE	0.163	0.148	0.749	418.400	10.067	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500- MEAN SEC	ALL VALUES MEAN CHLOHA	ALL VALUES 15- MIN DO
2693	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CHYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.000
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.029	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLOPA	ALL VALUES: 15-MIN DO	INDEX NO
2680	HOLLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	266
2681	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
2682	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	545
2683	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	157
2686	BANTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2689	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2610	BETSIE LAKE	77 (27)	77 (27)	80 (28)	17 (6)	86 (30)	94 (33)	431
2613	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2617	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2618	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2621	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2629	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2631	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2640	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2643	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2648	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2649	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2659	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2665	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2671	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2672	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2673	RUSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	74 (26)	325
2674	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2683	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2685	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (28)	242
2688	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2691	MONA LAKE	3 (1)	3 (1)	37 (13)	42 (15)	17 (6)	20 (7)	123
2692	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500- MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15- MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2618 CHEMUNG LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 5.38

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2618A1	5.38	2.10	3.47	8.75	6.07	3.99	1.55	1.64	0.70	0.50	1.45	1.70	2.48	2.87
261881	1.60	0.62	1.03	2.60	1.81	1.19	0.46	0.49	0.21	0.15	0.43	0.50	0.74	0.85
2618ZZ	3.78	1.47	2.43	6.15	4.27	2.81	1.09	1.15	0.49	0.35	1.02	1.19	1.74	2.01

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 5.38
SUM OF SUB-DRAINAGE AREAS = 5.38

TOTAL FLOW IN = 34.39
TOTAL FLOW OUT = 34.40

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2618A1	10	72	3.10	29	7.60				
	11	72	5.80	21	6.30				
	12	72	7.60						
	1	73	12.00	7	18.00				
	2	73	4.90	4	9.00				
	3	73	16.00	4	12.00				
	4	73	9.00	6	12.00	22	8.10		
	5	73	6.70	6	4.90	20	3.80		
	6	73	3.20	2	5.80				
	7	73	1.50	7	2.00				
	8	73	1.00	4	1.20				
	9	73	0.50	8	0.30				
	10	73	1.00	13	0.80				
261881	10	72	0.90	29	2.30				
	11	72	1.70	21	1.90				
	12	72	2.30						
	1	73	3.60	7	5.20				
	2	73	1.50	4	2.70				
	3	73	4.80	4	3.50				
	4	73	2.70	6	3.50	22	2.40		
	5	73	2.00	6	1.50	20	1.10		
	6	73	0.90	2	1.70				
	7	73	0.40	7	0.60				
	8	73	0.30	4	0.40				
	9	73	0.20	8	0.10				
	10	73	0.30	13	0.20				

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2618 CHEMUNG LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
261822	10	72	2.20						
	11	72	4.10						
	12	72	5.40						
	1	73	8.50						
	2	73	3.50						
	3	73	11.00						
	4	73	6.30						
	5	73	4.70						
	6	73	2.20						
	7	73	1.00						
	8	73	0.70						
	9	73	0.40						
	10	73	0.70						

APPENDIX C

PHYSICAL and CHEMICAL DATA

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STORET RETRIEVAL DATE 75/02/04

261601
42 34 41.0 083 50 12.0
LAKE CHEMUNG
26 MICHIGAN

11EMALES 2111202
3 0035 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/15	13 40	0000	22.9	9.4	144	405	8.58	143	0.020	0.020	0.017	0.010
	13 40	0015	19.8	8.0		410	8.53	156	0.020	0.020	0.018	0.010
	13 40	0025	10.6	0.2		420	7.43	165	0.020	0.040	0.034	0.015
	13 40	0035	7.5	3.0		426	7.38	166	0.020	0.240	0.051	0.027
72/09/19	14 14	0000			76	383	8.03	119	0.060	0.090	0.017	0.010
	14 14	0004	21.7	8.9		380	8.60	119	0.050	0.090	0.018	0.012
	14 14	0015	20.2	8.5		370	8.15	128	0.050	0.070	0.023	0.012
	14 14	0025	14.5	6.0		415	7.58	156	0.080	0.340	0.039	0.015
72/11/15	11 25	0000			66	420	7.96	137	0.020	0.040	0.033	0.014
	11 25	0004	6.1	11.2		410	7.98	134	0.020	0.040	0.037	0.014
	11 25	0015	6.0	11.2		410	7.90	135	0.020	0.040	0.032	0.014
	11 25	0025	6.0	11.2		410	7.96	134	0.020	0.040	0.072	0.014

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/15	13 40	0000	7.30
72/09/19	14 14	0000	8.30
72/11/15	11 25	0000	32.00

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

2S1502
42 33 14.0 083 51 17.0
LAKE ERIE-MONG
26 MICHIGAN

11EPALES
3

2111202
0065 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/05/15	14 20	0000	22.7	9.4	144	405	8.60	145	0.030	0.020	0.012	0.006
	14 20	0015	17.7	12.3		415	8.58	152	0.020	0.010K	0.014	0.012
	14 20	0030	8.2	3.6		425	7.51	156	0.070	0.010K	0.015	0.010
	14 20	0035	6.3	0.0		430	7.33	158	0.140	0.620	0.096	0.080
72/09/19	14 30	0000			12	368	8.03	119	0.060	0.100	0.015	0.012
	14 30	0004	21.5	9.7		385	8.62	120	0.040	0.080	0.017	0.010
	14 30	0015	20.7	7.4		365	8.58	120	0.040	0.080	0.017	0.009
	14 30	0025	13.6	0.0		405	7.55	147	0.110	0.170	0.024	0.012
	14 30	0040		0.0		400	7.50	137	0.090	0.410	0.027	0.021
	14 30	0050	6.5	0.0		410	7.38	142	0.100	1.480	0.150	0.127
72/11/15	11 00	0000			12							
	11 00	0004	6.8			420	7.60	137	0.040	0.180	0.038	0.014
	11 00	0015	6.7	7.4		410	7.60	137	0.020	0.160	0.034	0.013
	11 00	0025	6.7	7.0		405	7.60	135	0.020	0.160	0.034	0.013
	11 00	0040	6.7	6.8		410	7.60	134	0.020	0.150	0.042	0.013
	11 00	0058	6.8	6.8		410	7.60	136	0.030	0.170	0.071	0.013

DATE FROM TO	TIME OF DAY	DEPTH FEET	32211 CHLRPHYL A UG/L
72/05/15	14 20	0000	7.2J
72/09/19	14 30	0000	5.3J
72/11/15	11 00	0000	19.2J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY DATA

STORET RETRIEVAL DATE 75/02/04

2618A1 LS2618A1
42 35 30.0 083 51 30.0
UNNAMED OUTLET CREEK
26 7.5 BRIGHTON
U/LAKE CHEMUNG
RD BRDG N LK CHEMUNG .1 MI W HUGHES RD
11EPALES 21112U4
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	11	25	0.190	1.550	0.075	0.005K	0.025
72/11/21	10	20	0.031	1.020	0.086	0.007	0.050
73/01/07	12	40	0.061	1.500	0.026	0.005K	0.044
73/02/04	09	00	0.044	0.840	0.023	0.005K	0.025
73/03/04	39	00	0.074	0.420	0.027	0.005K	0.030
73/04/06	04	00	0.024	1.500	0.044	0.005K	0.040
73/04/22	10	40	0.044	1.050	0.033	0.007	0.050
73/05/06	11	50	0.013	1.000	0.032	0.007	0.050
73/05/20	14	10	0.010K	0.460	0.004	0.004	0.035
73/06/02	12	20	0.012	1.700	0.046	0.009	0.025
73/07/07	11	45	0.010K	0.540	0.034	0.009	0.015
73/08/04	14	50	0.029	2.000	0.045	0.011	0.025
73/09/04	12	45	0.021	1.470	0.420	0.006	0.065
73/10/13	08	50	0.012	1.540	0.140	0.020	0.065

K VALUE KNOWN TO BE
LESS THAN INDICATED

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STORET RETRIEVAL DATE 75/02/04

261881 L5261881
42 35 00.0 083 50 30.0
UNNAMED CREEK
26 7.5 BRIGHTON
T/LAKE CHEMUNG
HUGHES RD BRDG E SIDE LAKE CHEMUNG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/29	11 35		0.210	1.550	0.160	0.005K	0.056
72/11/21	10 30		0.066	1.840	0.097	0.005K	0.028
73/01/07	12 30		0.138	1.980	0.140	0.011	0.058
73/02/04	09 10		0.076	1.600	0.170	0.005K	0.030
73/03/04	09 05		0.250	1.800	0.320	0.010	0.055
73/04/06	09 10		0.034	1.700	0.069	0.005K	0.030
73/04/22	10 30		0.023	1.600	0.025	0.005K	0.035
73/05/06	11 45		0.010K	3.050	0.024	0.005K	0.040
73/05/20	14 00		0.010K	2.730	0.036	0.006	0.040
73/06/02	12 15		0.056	2.800	0.336	0.020	0.045
73/07/07	11 55		0.011	2.400	0.024	0.006	0.045
73/08/04	13 00		0.010K	3.000	0.048	0.012	0.065
73/09/08	12 30		0.021	1.800	0.100	0.017	
73/10/13	09 00		0.019	1.950	0.093	0.028	0.075

K VALUE KNOWN TO BE
LESS THAN INDICATED